Army Engineers Develop Model to Support Iraqi Water Management

By Ms. Nani Gould and Mr. Fauwaz Hanbali

A country torn apart by decades of cultural and political violence, postwar Iraq is working to rebuild its towns and restore its economy. Thousands of displaced Iraqis are now seizing the opportunity to return to their homes and their indigenous way of life. This is the case for the Madan, or Marsh Arabs, who have resided in the delta region of Iraq for 5,000 years and were targeted by the former regime after the first Gulf War for giving sanctuary to rebels. The Madan relied heavily on the marshes to sustain their way of life until 1991, when the Ba'athist regime began to drain the marshes, destroy towns, and force the Madan to flee their homes. The Tigris and Euphrates River system was diverted from its normal path through 8,000 square miles of marshes to a direct route into the sea, ultimately turning the thriving marshlands into a desert. Today, there is much interest in evaluating the existing water management system in Iraq and the possibilities it can provide for restoration of these marshes.

For a nation that relies on other countries for most of its water supply, Iraq is urgently working to restore its own water system infrastructure. Under the old regime, technology used to manage dams and canals fell short of systems used in much of the industrialized world. The Ministry of Water Resources (MoWR), formerly the Ministry of Irrigation, is beginning to modernize the water system with the latest technology and state-of-the art software for support of its water management mission. It is undergoing substantial rehabilitation after suffering considerable postwar losses, especially technical references and computer resources, due to fire damage and looting.

Reservoir Simulation Model

To assist in this effort, the US Army Corps of Engineers (USACE) and the US Agency for International Development (USAID), an independent federal government agency that funds development projects in many countries, have partnered to help restore the Iraq marshland ecosystem through improved management of the nation's water infrastructure and natural resources. Heading up this effort to revive Iraq's water system infrastructure is the USACE Hydrologic Engineering Center (HEC), in collaboration with Development Alternatives, Incorporated, the USAID agent. HEC is developing a reservoir simulation model for the Tigris and Euphrates River system in Iraq. This model will provide a means for performing water resources planning studies, as well as decision support for Iraqi officials managing the real-time operation of the country's intricate system of dams and canals.

Photo courtesy US Army Corps of Engineers

A traditional Marsh Arab hut in southern Iraq, where the Ministry of Water Resources—with help from American agencies—is restoring the Mesopotamian marshes.

From the outset, it was recognized that Iraq's geographical setting and environmental factors posed challenging situations for hydrologists to consider for this project, including uneven distribution of precipitation and a natural topography that is not conducive to drainage. The water management model would need to account for all of the water coming into Iraq, including its storage, release, and movement. It would also be used to simulate historical events—in particular, extreme flood and drought periods. The end result is the HEC's Reservoir System Simulation (HEC-ResSim), a decision support tool that uses state-of-the-art software to aid the MoWR in its operation of the complex water management system in Iraq.

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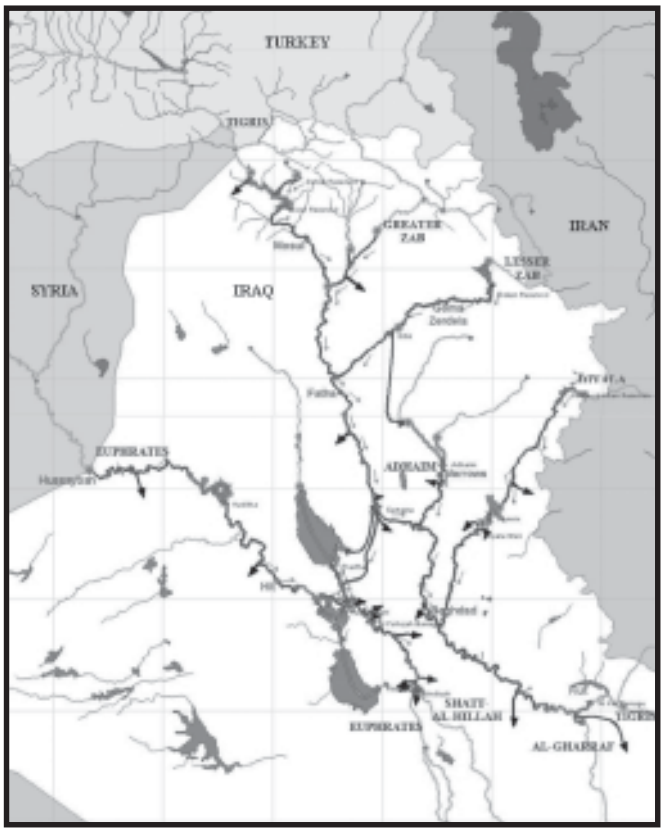

Photo courtesy US Army Corps of Engineers Hydrologic Engineering Center

A preliminary HEC-ResSim schematic shows a network of dams and reservoirs throughout the system.

Iraq's marshlands have complex flow patterns and require specialized models to analyze the flow circulation through the marshes. At the same time, there is a great interest by those devoted to marsh restoration to be able to use the output from the HEC-ResSim water management model to determine critical matters such as whether there is enough water available to restore the marshes to their historic levels. In developing the model, HEC employed a two-phased approach that initially produced a preliminary water balance model that covers the Tigris and Euphrates Rivers, as well as their tributaries in Iraq.

Phase I

Completed in November 2003, Phase I successfully developed the concept of the water control system, established a relationship between HEC and Iraqi engineers, and implemented operational rules and criteria. Specifically, HEC researched public sources and accumulated essential publications, reports, and data relating to the hydrology of the Tigris and Euphrates watersheds. HEC also hosted two Iraqi engineers from the MoWR to complete the preliminary reservoir model. The partnership between HEC and the Iraqi engineers proved to be a vital component in developing an accurate water simulation model. Their hands-on experience and familiarity with Iraq's topography, as well as years of data carefully recorded in notebooks, provided the criteria for the HEC-ResSim model. Additionally, a comprehensive review of the watershed layout was conducted, the reservoir network connectivity was verified, and historical stream flow records dating back to 1930 were digitally archived into the HEC data storage system.

The HEC-ResSim software was used to construct a geographically referenced model of the reservoir system in Iraq. The model consists of six major reservoirs, three massive off-stream storage reservoirs, seven chief barrages, and many diversions to reflect water withdrawals along different reaches of the Tigris, its tributaries, and the Euphrates. The primary reservoirs include the Mosul Reservoir downstream of the Turkish-Syrian border on the Tigris and the Haditha Reservoir on the Euphrates. Basic model input incorporates reservoir storage capacity curves, individual outlet capacities, power plant characteristics, river reach flow routing parameters, water demand diversion requirements, reservoir seasonal target levels, and rules of operation. The primary objectives of the reservoirs in the model are to generate hydropower, mitigate flooding, and supply water for irrigation, because approximately 85 percent of Iraq's water supply is used for irrigation purposes.

Reservoirs are key to the capture and storage of floodwaters to meet the country's irrigation requirements and ensure that Iraq's primary crops—including wheat, barley, and rice—are farmed successfully. In addition, the recent return of date palm orchards has brought back an important part of the economy in southern Iraq. Vegetative covers such as reeds are harvested commercially for building materials, and water

Photo courtesy US Army Corps of Engineers

Upcoming USACE projects include rehabilitation of water control structures such as these gates at Mosul Dam.

buffalo, a traditional livestock of the Iraqi people, have also returned to the marshes. The water supply will be critical to ensuring that all these components of the restored ecosystem thrive and grow.

Phase II

This phase began in January 2004 and should be completed by the end of the year. HEC will continue to reestablish and modernize water management in Iraq and coordinate with the MoWR and interested parties. Primary objectives include an on-site assessment of existing stream gage network and upgrade needs, as well as refinement of the reservoir model to analyze existing and projected water shortages in the system.

A training course is planned for the HEC-ResSim model in Baghdad, upon completion of Phase II. The goal is for two HEC staff members to travel to Baghdad and present one week of training for up to 30 MoWR engineers. Training will focus on use of the software and model for real-time decision support and planning studies. Currently, however, technology transfer between the HEC—located in Davis, California, and the MoWR headquartered in Baghdad—has proven to be challenging.

Far-Reaching Impacts

The HEC-ResSim model has drawn attention from around the world. USACE personnel stationed in Afghanistan have shown interest in the model for similar work they are doing in that country. This model is expected to have far-reaching impacts, and hopefully it will be used in other countries that need help studying and solving reservoir system management problems. HEC and the Afghanistan Engineer District recently teamed up to develop a reservoir simulation model of Kajakai Reservoir and other projects in nearby valleys. The model will simulate system operations for hydropower, flood control, and irrigation, reflecting substantial planned upgrades to the reservoir's generating capacity, live storage, and discharge facilities. USACE is continuing to evaluate the software for additional projects and future partners.

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